

Measure: Residential PV (G2e)

Increase uptake of residential PV by 400 homes per year resulting in adding 200kW of residential rooftop solar annually.

COT ARRA RFP Summary:

Emission reduction potential by 2020:	2,910 tCO ₂ e/yr. in 2012; 29,104 tCO ₂ e/yr. by 2020
Percentage of goal (2012):	0.3%
Percentage of goal (2020):	1.3%
Total annual average implementation costs:	\$3.465 million per year
Entity that bears the costs of implementation:	Homeowners (\$3.44 million/yr) and City of Tucson (\$25,000/yr)
Savings per tCO ₂ e over life of program:	\$72
Net annual savings:	\$976 per home
Entity that realizes the financial return:	Ratepayer
Equitability (progressive/regressive, income/revenue neutral, etc):	Neutral
Potential unintended consequences:	Homeowner investments for GHG reduction directed away from other investments with higher savings potential

Background information:

Solar electric systems, or photovoltaic (PV), convert solar radiation into useful forms of energy. Solar resources are most abundant in the southwestern US, therefore making this location the most applicable for large-scale implementation.¹ Decentralized residential PV in Tucson provides homeowners with clean, renewable energy that helps offset their fossil fuel derived energy needs while utilizing the region's most abundant natural resource.

This fact is not going unrecognized. According to Rep. Gabrielle Giffords:

*"In the first six months of 2010, nearly 1,100 homeowners installed residential solar systems with SunShare rebates from TEP. That is more residential solar systems than had been installed in the previous nine years in TEP's service area."*²

When coupled with energy conservation and energy efficiency, this distributed energy solution can lead to important GHG emission reductions, spur local businesses, and create jobs.

The major obstacle to such installations is the large capital investment of PV systems. To overcome this hurdle, the City of Berkeley designed and implemented a financing mechanism that allows the homeowner to add the cost of the system to their property tax bill. Therefore, PV owners spread the capital costs over 20 years, and the system's financing mechanism stays with the home in case of sale.

Property tax based financing has now gained traction and is commonly referred to as PACE (Property Assessed Clean Energy) financing. According to the Alliance to Save Energy:³

"PACE financing allows property owners to benefit from energy savings immediately while spreading the cost of improvements over a number of years. The PACE model addresses and overcomes challenges that both borrowers and lenders have identified in seeking to use traditional finance mechanisms to fund efficiency improvements."

However, the use of PACE systems has been temporarily suspended because the Federal Housing Financing Agency (FHFA) has stated that PACE financing mechanisms do not meet the Fanny Mae and Freddie Mac federal mortgage requirements.⁴ Solutions to this problem are under development.

Residential PV systems now average approximately 5 kilowatts, will in Tucson produced 8,500 kWh/year and have a pre-incentive cost of approximately \$28,000.⁵ With existing rebates from the Federal government, the State of Arizona and Tucson Electric Power, the present cost to homeowners is approximately \$8,600. Over its lifetime, these initial costs represent 90% of system ownership costs.⁶

Financing this cost remains a potential barrier for homeowners, and over the 10-year life of this measure from 2011-2020, it is likely that the existing rebates will end and the financing issue for homeowners will become a greater barrier. Private companies have developed system lease products that may solve the financing problem (and take on system ownership challenges such as system maintenance), but it is uncertain whether these models will work if/when rebates end, or work with existing Tucson rebates.⁷ For example, the lease approach may not work together with the present TEP \$10,000 rebate because of TEP's ownership of the Renewable Energy Credits associated with the system.

Description of Measure and Implementation Scenario:

The measure is a commitment by the City of Tucson to remove financing barriers such that 400 PV systems averaging 5 kilowatts and producing 8,500 kWh/yr are installed in Tucson each year from 2011-2020.

This will likely involve general regulatory approaches such as adopting a PACE system for use by Tucson citizens, plus specific remedies that may be required to address financing system shortfalls that are presently not predictable, such as City-provided low-interest loans, etc.

Whether or not additional financing is made available to property owners, this measure can be combined with the Residential Community Climate Challenge (Measure E14). As the Climate Challenge is a public education campaign, marketing of the financial and energy savings and financing options need to be made clear to potential participants.

Has the Measure been implemented elsewhere and with what results?

The City of Berkeley implemented a PACE-type system pilot program named Financing Initiative for Solar and Renewable Technology (FIRST) that is intended to assist homeowners with the capital costs of installing solar energy systems.⁸ FIRST allows a citizen to borrow money from the City, which is then paid back over the life of the loan via increases in their property tax bills, and the City of Berkeley has produced an implementation guide for local governments.⁹

Berkeley's pilot can be considered a success. They targeted 40 homes and ended with 13 PV systems installed under the FIRST mechanism and more via home equity loans (due to the more favorable interest rates). According to the survey in their assessment, knowledge of and access to financing to overcome the capital costs of utilizing solar PV had significant influence in their participation.⁴

The City of Austin, Texas has a successful PV rebate program administered by its utility Austin Energy. Through March 2010, the rebates have facilitated more than 1000 "customer-owned" systems plus 128 commercial/municipal systems, totaling 4 MW of

solar capacity. The present residential solar rebate is \$2.50 per watt, limited to \$15,000 per year and \$50,000 per site.¹⁰

Energy/Emission analysis:

A 5 kilowatt PV system in Tucson can be expected to produce 8,500 kWh/year.⁵ This will displace 8,500 kWh/year of electricity from TEP, which presently produces 856 grams of CO₂e per kWh (this ratio will vary over time – this analysis assumes it does not change over the 20 year projected life of the PV system). Each system therefore is projected to reduce 146 tCO₂e.

The 4,000 systems installed 2011-2020 will, over their lifetimes, reduce emissions by ~582,000 tCO₂e.

Description	Input	Notes
Expected electricity production of a typical 5 kilowatt residential PV system in Tucson, AZ	8,500	kWh/year
COT electricity grid emissions factor	856	Grams CO ₂ e/kWh
Expected annual GHG savings per home per year	7.3	tCO ₂ e
Residential PV uptake		
Homes assumed to utilize increased incentives and install PV per year 2011-2020	400	
Resulting GHG mitigation potential over life of program	582,080	tCO ₂ e

Contribution analysis:		
COT 1990 Citywide GHG emissions (baseline) ¹¹ :	5,461,020	tCO ₂ e
MCPA 7% reduction target for COT:	5,078,749	tCO ₂ e
2012 BAU GHG emissions projection:	7,000,000	tCO ₂ e
2020 BAU GHG emissions projection:	7,343,141	tCO ₂ e
GHG emissions reduction to meet 7% goal (2012):	1,921,251	tCO ₂ e
GHG emissions reduction to meet 7% goal (2020):	2,264,392	tCO ₂ e
Residential PV- Increased Uptake		

Contribution of G2d Residential PV in 2020:	29,104	tCO ₂ e
% Contribution of G2d Residential PV to 2020 annual goal:	1.3	%

Economic analysis:

This analysis is completed from the homeowner's and City's perspective.

Description	Input	Notes
Average home electricity use in Tucson	11,000	kWh
Annual electricity production from system	8,500	kWh
Electricity costs per kWh 2011-2020	\$0.08 to \$0.10	Current average residential rates, increasing 2.4%/yr
Capital cost of 5 kW PV system	\$28,000	
TEP Upfront Incentive	\$10,000	\$2/Watt
State rebate	\$1,000	
Federal rebate	\$8,400	30% of gross amount ¹²
Homeowner net capital cost	\$8,600	

Measure Costs

We assume that administering the measure requires 0.25 FTE at the City, costing \$25,000 per year for 10 years. We have also assumed that the City can implement a program that reduces homeowner costs sufficiently, such as a PACE-like program, without involving the City in borrowing to create a low-interest loan fund or otherwise causing City use of funds for which there is a cost of money.

Homeowners will invest \$8,600 for 4000 PV systems over ten years = \$34.4 million.

Total costs: \$34.65 million

Measure Savings

Based on the above inputs, the total savings to a homeowner installing a 5 kWh PV system has a payback period of just over 11 years. Over its 20-year life, a system installed in 2011 is projected to save \$17,197; a system installed in 2020 is projected to save \$21,799.

The savings of a system installed in 2011 will pay back the \$8,600 initial cost in early 2022, and then generate a net savings of \$17,197 - \$8,600 = \$8,597.

However, if the homeowner financed the \$8,600 at 6% interest over ten years (current minimum credit union rate for home equity loan), interest payments would total \$2,857, reducing the net savings to \$14,340 and extending the payback term to early in 2025. This example is offered to illustrate the need for better financing options than home equity or other forms of capital cost financing.

A system purchased without interest costs in 2011 for \$8,600 is projected to achieve **savings** of \$59 per tCO₂e reduction.

Measure's Net Economic Impact

Costs 2011-2020: \$34.65 million

Benefits over life of program (2011-2039): \$76.7 million

Net savings over life of program (2011-2039): \$42.1 million

The program is projected to save \$72 per tCO₂e reduction over its life.

The net economic impact is estimated as the savings from 4000 systems of an average of ~\$19,500 per installed system = ~\$76.7 million. Because these savings result from local economic activity by solar installers and possibly solar manufacturing operations, it is reasonable to apply the multiplier used in this analysis of 1.5 to reach a net economic impact over the lifetime of the systems as \$115 million.

Co-benefits:

Installation of PV systems cushion owners from fossil fuel rate spikes and it is reported that energy efficiency upgrades increase home resale values.¹³ Moreover, incentivizing accelerated uptake of clean technology can help spur the local economy and small businesses. It also helps in job creation based on the new demand for skilled and knowledgeable plumbers. Lastly, this Measure is synergetic with the Community Climate Challenge (Measure E14), and the two, among others, should be considered in concert.

Equitability:

Such systems are only impact those who participate in the program. Due to the capital costs involved, even after rebates, the measure is not income neutral.

Potential unintended consequences:

The primary unintended consequence could be direction (via the financing system plus rebates) of homeowner capital funds that reduce GHG emissions away from energy conservation or other investments that might achieve greater GHG savings per dollar invested.

Other potential unintended consequences include:

- The increased use of electricity due to the availability of lower cost energy;
- The GHG savings may not be permanent if the financing scheme or other aspects of the investment result in the system's removal prior to its useful life.
- The manufacture of PV systems using current fossil-fuel dominated energy sources creates more global GHGs than the systems save.

Endnotes:

Notes:

1. *TEP's financial analysis (NOTE 5) has outdated system costs and has a miscalculation relative to the federal rebate. Moreover, the simple payback methodology assumes that energy prices remain constant over the life of their analysis (ie, 27 years). This analysis included herein based on current pricing and increasing energy costs achieves a payback 2x faster than the TEP analysis.*
2. *TEP assumes the rights to the Renewable Energy Credits (RECs) for the 20-year life of a PV system that utilizes TEP's Up Front Incentive (UFI). These RECs help TEP meet their renewable energy goals set by the Arizona Corporation Commission.*
3. *All references retrieved October through December of 2010 unless otherwise noted.*

¹ http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10710.

² <http://www.hillpundit.com/blogs/congress-blog/homeland-security/120505-solar-boom-underway-in-tucson-southern-arizona-rep-gabrielle-giffords>.

³ http://ase.org/sites/default/files/PACE_factsheet.pdf.

⁴ See: pacefinancing.org.

⁵ Based on a 1 December 2010 meeting with Tucson's Solar Energy Coordinator, Bruce Plenk, and arizonagoessolar.com.

⁶ Sungevity website, "Solar Home Lease," at: <http://www.sungevity.com/solar-lease>.

⁷ Solar system leases are offered by Sungevity, SunRun and Solar City. The Sungevity lease, for example, requires no down payment and allows the system lease to run over a ten-year period, during which the inverter is replaced free if it fails. Energy production performance is guaranteed. After year six, the homeowner has the option to purchase the system at fair market value; after expiration of the original 10-20 year lease period, the homeowner has the option to extend another five years. See: <http://www.sungevity.com/solar-lease>.

⁸ Berkeley FIRST Initial Evaluation:
[http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Berkeley%20FIRST%20Initial%20%20Evaluation%20%20final%20\(2\).pdf](http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Berkeley%20FIRST%20Initial%20%20Evaluation%20%20final%20(2).pdf).

⁹ http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Guide%20to%20Renewable%20Energy%20Financing%20Districts2009.pdf.

¹⁰ See Austin Energy rebate website at:
<http://www.austinenenergy.com/Energy%20Efficiency/Programs/Rebates/Solar%20Rebates/index.htm>.

¹¹ PAG Regional Greenhouse Gas Inventory- 2010.

¹² PV owners will have to pay income taxes on the federal rebate via a 1099 form.

¹³ <http://www.nrel.gov/docs/legosti/fy96/17459.pdf>.